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COVER SYSTEM PLAN - FIGURE 5-1 PRINTS TOO LIGHT

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LETTER OF TRANSMITTAL

TO:	U.S. Environmental Protection Agency c/o Crab Orchard National Wildlife Refuge 8588 Route 148 Marion, IL 62959	FROM:	Gary M. Wantland, P.E. 7650 W. Courtney Campbell Causeway Tampa, FL 33607-1462	DATE: Attention: JOB No.:	May 11, 2001 Kevin Turner C100004051.00

RE: Sauget Area I TSCA Containment Cell Design Report

The following items are being sent: ☒ Attached ☐ Under separate cover by ______

☐ Shop Drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications ☐ Copy of Letter

☐ Other

Copies	Date or Number	Description
3	May 11, 2001	Remove and replace Table of Contents with the attached
3	May 11, 2001	Remove and replace Section 5 with the attached
3		Remove Figures 5-1 and 5-8. Insert the attached Figures 5-1, 5-8, 5-9 and 5-10
3		Remove and replace Appendix D with the attached
3	April 30, 2001	IEPA Response to Comment Sauget Area 1 TSCA Containment Cell Design Report

Transmittals for reasons checked:

☐ For Your Approval ☐ No Exceptions Taken ☐ Resubmit ______ copies for approval

☒ For Your Use ☐ Make Corrections Noted ☐ Submit ______ copies for distribution

☐ As Requested ☐ Amend and Resubmit ☐ Return ______ corrected prints

☐ For Review and Comment ☐ ______

Remarks: Enclosed are the revised table of contents, figures, Section 5 and Appendix D to be inserted and/or replaced for the Sauget Area 1 TSCA Containment Cell Design Report submitted on April 2, 2001. If you have any questions, please call.

Copies: Mike Light - Solutia Inc,
Bruce Yare, P.E. - Solutia Inc.

If enclosures are not as noted, kindly notify us at once.

Lisa Woodard for
Gary M. Wantland

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Tampa, FL 33607-1462
Tel: 813.286.1711
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1630200005 - St. Clair County
Sauget Area 1, Dead Creek
Sediment Containment Cell
Superfund/Technical File

Reviewer: Rob Watson
Review Dates: April 30, 2001

Response to Comments on Sauget Area 1 TSCA Containment Cell Design Report
Time Critical Removal Work Plan, Dead Creek Sediment and Soil in Sauget and Cahokia

Introduction

On April 2, 2001, Solutia submitted the Final Sauget Area 1 TSCA Containment Cell Design Report. On April 30, 2001 Solutia received additional comments from IEPA regarding design of the final cover system. The following is Solutia's response to those comments.

COMMENT	EPA/IEPA DISCUSSION OF RESPONSE TO COMMENTS	SOLUTIA RESPONSE
84.	The following comments are related to Comment 84:	
a.	The calculations for Qmax in Appendix D (the first set of calculations under Cover System Stormwater Control) are not legible. A darker copy of these calculations needs to be provided.	A clearer set of calculations are provided to replace the previous unreadable version. Please remove all of Appendix D and insert the attached replacement set.

COMMENT	EPA/IEPA DISCUSSION OF RESPONSE TO COMMENTS	SOLUTIA RESPONSE
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c.	A detail drawing (like Figure 5-8) of the downchute outlet, and its relationship to Dead Creek needs to be provided. Figure 5-8 is titled "Downchute Outlet Detail," but it is actually the downchute inlet.	The figures in Section 5 were revised to provide the requested details. Figure 5-1 was modified to clarify how the details shown in Figures 5-6 through 5-10 relate to the plan view. Existing Figure 5-8 was renumbered to Figure 5-9. Figures 5-8 and 5-10 were added to provide the detail requested. Please remove Figures 5-1 and 5-8 and inset the attached Figures 5-1, 5-8, 5-9, 5-10. In addition Section 5 was revised to identify the new figures and to clarify the design of the cover system. Please remove the Section 5 text and replace it with the attached.
d.	The responses to Comment 84 in Part II (Item 89) and Part II, Group II (Item 118) need to be revised since they still do not address each portion of the comment individually.	Please see the information provided below.
84. Part II (Item 89) and Part II, Group II (Item	<u>Run-Off Control Systems, Section 5.5</u>: The design of the landfill needs to include a run-off control system that is capable of holding the stormwater from a 25-year, 24-hour storm after the unit is closed. It is not	During construction, stormwater in the cell will be pumped from the cell and discharged to Dead Creek. After sediment transfer, stormwater in the cell will be treated, as required, and discharged to the POTW. Once the cover is installed, sedimentation will be controlled using best management practices. After vegetation is established, there is no need to control

COMMENT	EPA/IEPA DISCUSSION OF RESPONSE TO COMMENTS	SOLUTIA RESPONSE
118)	acceptable to discharge the run-off from the closed landfill directly to Dead Creek. A run-off control system for the closed landfill will prevent sediments from washing off the landfill and into the restored Dead Creek. Also, if the cover system fails, and the run-off becomes contaminated, the run-off control system will prevent the contaminated run-off, sediments and wastes, from entering and contaminating the restored Dead Creek. The description of the run-off control system needs to include the following:	runoff from the cell. Stormwater runoff will be routed to a drainage swale on the north side of the cell that discharges to Dead Creek. Design drawings for this swale, which is designed to handle a 25-year, 24-hour storm, are included in Attachment 25 of this Response to Comments Document. They will be included as Figures 5-1 and 5-6 of the Design Report.
a.	<u>Design and Performance</u> Describe the run-off collection and control system design. Provide calculations demonstrating that the system has sufficient capacity to collect and hold the total run-off volume. Provide a plan view showing the locations of the run-off control system components, along with sufficient drawing details and cross sections. Indicate the fate of the collected run-off.	Section 5.4 describes the cover design and Section 5.5 describes the Run-Off Control Systems. The calculations demonstrating the performance of the final cover system are described in Section 5.5 and included in Appendix D. Figure 5-1 presents the requested plan view of the cell. Details of the stormwater management system are presented in Figures 5-5, 5-6, 5-8, 5-9, and 5-10. The fate of the collected run-off is described in Section 5.
b.	<u>Calculation of Peak Flow</u>: Identify the total run-off volume expected to result from at least a 24-hour, 25-year storm. Describe data sources and methods used to make the peak flow calculation. Provide copies of the calculation. Provide copies of the calculations and data, including appropriate references.	Details of the calculations used to calculate peak flow are presented in Appendix D and in Section 5.5.

COMMENT	EPA/IEPA DISCUSSION OF RESPONSE TO COMMENTS	SOLUTIA RESPONSE
c.	Management of Collection and Holding Units: Describe how collection and holding facilities associated with run-on and run-off control systems will be emptied or otherwise managed expeditiously after storms to maintain system design capacity. Describe the fate of liquids discharged from these systems.	Management and fate of stormwater run-off is presented in Section 5.5
d.	Construction: Provide detailed construction and material specifications for the run-off control systems. Include descriptions of the construction quality control program that will be utilized to assure that construction is in accordance with design requirements.	Construction of the cover system is addressed in Section 6. In addition, the Specifications included in Appendix E, and the Construction Quality Assurance Plans in Appendices F and G address the construction requirements.
e.	Maintenance: Describe any maintenance activities required to assure continued proper operation of the run-off control systems throughout the active life of the unit.	Maintenance issues are addressed in Section 5.5 and in Section 6.4

1630200005 - St. Clair County
Sauget Area 1, Dead Creek
Sediment Containment Cell
Superfund/Technical File

Reviewer: Rob Watson
Review Dates: April 30, 2001

Response to Comments on Sauget Area 1 TSCA Containment Cell Design Report Time Critical Removal Work Plan, Dead Creek Sediment and Soil in Sauget and Cahokia

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5.1 CLOSURE PLANS

The containment cell will incorporate an impermeable cover to reduce infiltration into the completed cell. The cover will be sloped to promote stormwater run-off and will incorporate structural features to direct and control the run-off from the elevated cover. The cover slope also provides for potential settlement of the contained wastes. The impermeable cover will be constructed to completely encapsulate the materials placed within the cell.

5.2 CLOSURE PERFORMANCE STANDARD

The cover system of this landfill is designed to:

- minimize the need for further maintenance, and
- control, minimize or eliminate the post closure escape of materials within the landfill to the ground or surface water surrounding the site.

The closure plan provides an engineered cover system that controls and routes stormwater to reduce cover erosion. The cover will incorporate an impermeable composite lining system that will reduce the infiltration into the wastes and subsequent leachate generation. A geonet drainage composite will intercept and route water infiltrating the cover soil layer to reduce the head on the cover lining system. The cover soil layer will be 24 inches thick to provide adequate rooting depth for the grassing on the cover. The grassing will reduce soil erosion.

A sand layer will be placed over the completed waste fill to provide a gas permeable zone for a gas vent system through the cover system. Vent pipes will penetrate the cover system to provide relief for gases generated by the wastes and to vent barometric pressure changes.

The impermeable cover composite lining system substantially reduces liquid infiltration into the wastes and subsequent leachate generation. The cover system will be installed after all waste materials have been interred there.

5.3 COVER SYSTEM DESCRIPTION

The landfill cover is designed to prevent infiltration of stormwater into the waste material and promote rapid run-off of stormwater during rainfall events. At a minimum, the cover system will include the following from bottom to top:

- 6 inches of tracked in-place sand
- geosynthetic clay liner
- 60-mil HDPE geomembrane (textured)
- geotextile fabric
- geonet drainage layer
- geotextile fabric
- 24 inches of soil and drainage layer to support the vegetation cover

5.4 COVER DESIGN

5.4.1 General

The cover system for the proposed containment cell will be a multi-component composite lining with gas collection and subsurface drainage layers. The proposed cover system is designed to provide a degree of impermeability equivalent to the bottom lining system. Surface grades for the containment cell side slopes are no steeper than 4:1 for ease of mowing and maintenance. The central cover area will have a surface slope between 3 and 12 percent depending on the waste volume. A raised berm around the central cover area routes stormwater to a precast downlet drop box and outlet channel at the toe of the 4:1 side slope. The total landfill plan area is about 5.4 acres. Figure 5-1 shows the proposed configuration of the cover system. Figure 5-2 shows a cross section of the proposed cover system. A description of the cover system components is provided below. The components are described in a bottom to top order.

The subgrade for the cover system will be the waste materials. The waste materials will be graded to mirror the final surface grades on the cover. Clean fill will be used if needed to provide the grades if there is not enough waste fill to meet the required grades. A 6-inch thick sand layer will be pushed and tracked into place over the graded subgrade to serve as the bedding for the linings and serve as a gas collection layer. Four gas vent structures will be distributed around the cover to vent the sand layer to the atmosphere. The vent stack will be constructed of 6-inch diameter PVC piping capped with a hood to prevent precipitation infiltration. The portion of the vent stack below the lining elevation is slotted to provide pneumatic connection to the sand layer. Each vent will include a 20-ft by 20-ft geonet layer to create an enhanced collection zone around the vent. Each vent stack excavation will be backfilled with gravel to provide a stable foundation. Each vent pipe passes through a fabricated boot in the HDPE lining to prevent seepage from entering the cell. Figure 5-3 presents a detail of the vent structure.

The 6-inch sand layer will be the bedding layer for the GCL materials. Bedding layer soils will have clods no larger than two inches, will be placed and compacted to 90% Standard Proctor Density and will have a moisture content at or near optimum. Bedding layers will be smooth with no ruts or sharp edges before, during and after installation of the overlying geosynthetic material. They will provide a surface capable of supporting the geosynthetics and other layers in the liner system. Specification 02200 - Earthwork, included in Appendix E, Technical Specifications, of the Design Report, will be used for control of placement of the geosynthetic bedding layers in the liner system.

A GCL will be placed over the sand layer. The GCL will be rolled into place and overlapped with adjacent panels. The GCL used in the cover will be a commercially available material composed of two geotextile layers sandwiching bentonite clay granules. The hydraulic conductivity of the GCL will be no greater than $1\text{x } 10^{-8}$ cm/sec. The GCL will have an internal shear strength of 50 psf (nominal) and a tensile grab strength of at least 50 pounds. Lateral and longitudinal seams will be completed by overlapping adjacent panels.

A 60-mil High Density Polyethylene (HDPE) lining will be placed directly over the GCL. The GCL and HDPE composite lining system extends over the entire lined waste cell and is buried in an anchor trench just outside the limits of the bottom lining anchor trench. The HDPE lining panels will be heat seamed to form a continuous membrane barrier. The seaming will be either pressure or vacuum tested to verify the integrity of the seams. Mechanical tests of the seam integrity will be performed by removing test samples from the completed lining and destructively testing the samples. The sample locations from the lining will be patched with an extrusion welded HDPE patch. The primary lining in the cover system will be constructed with 60-mil

HDPE membrane. The HDPE lining will be textured and will contain ultraviolet protectants. Although the HDPE manufacturer for this installation is currently undefined, manufacturers such as GSE Lining Technology or Poly-Flex Inc. produce linings meeting the requirements of the State of Illinois.

A geotextile/ geonet/ geotextile drainage composite will be placed directly on the HDPE lining to serve as a subsurface drain. The drainage composite will extend over the entire cover area and connect to perforated piping at the edge of the cover area. The perforated piping is connected to gravel covered outlets at ground surface to drain the collected water. The gravel prevents access to the drainage piping by animals.

A 24-inch earthen cover soil layer will be constructed over the geosynthetic drainage composite layer to provide a vegetated cover. The cover soil material will be a native soil suitable for grass growth and with a maximum particle size of ¼-inch. The cover soil layer will be compacted to at least 90 percent of the fill's maximum dry density as determined by ASTM D-698 to provide stability to the cover soil for mowing and maintenance. The grassing will be with grass seed mixes appropriate for Illinois, specifically IDOT Section 250 Seed Mixture Class 1.

HDPE membrane will be manufactured by GSE, Serrott or equivalent. Geotextile will be manufactured by Mirafi or equivalent. Geonet and geonet will be manufactured by Tenax or equivalent. GCL will be manufactured by CETCO, GSE, Serrot or equivalent. Manufacturers technical data sheets for these geosynthetics are included in Appendix H. Manufacturers technical data sheets for all geosynthetic components including Geomembrane, GCL, geotextile, geonet and geogrid are included as Appendix H of the Design Report.

5.4.2 Minimization of Liquid Migration

The proposed cover design provides a substantial long-term minimization of liquid migration through the cover system. Modeling of the cover system was performed using HELP. The model results indicate that the infiltration through the cover system is less than 1/1000 of 1 percent of the total precipitation falling on the cover system. The HELP results are provided in Appendix C.

5.4.3 Maintenance Needs

The proposed cover system was designed to minimize the amount of maintenance and to allow easy maintenance. The cover system incorporates relatively gentle slopes for ease of mowing. The lower portions of the side slopes include rip rap armoring to reduce erosion of the side slopes during flooding events in Dead Creek. The berm around the central cover area reduces the amount of stormwater flowing down the side slopes, reducing the erosion potential. The central cover area slopes are mild to reduce stormwater run-off velocity and erosion. The gravel covered subsurface drains on the cover help keep animals out of the drainage collection system to avoid gnawing injury to the system.

5.4.4 Drainage and Erosion

The cover system design incorporates a berm around the central cover area to route stormwater off the cover through an armored downchute. The velocity of sheet flow run-off on the cover varies between 0.25 and 0.44 ft per second for slopes between 3 and 12 percent, respectively. Grassed surfaces are appropriate for these flow velocities. Calculations for the sheet flow velocities are provided in Appendix D.

The geosynthetic drainage composite used as the subgrade drain has a transmissivity of 9×10^{-1} cm^2/sec. The geonet will be a 3-dimensional HDPE net between two layers of non-woven geotextile fabric. The drainage composite will directly contact the underlying HDPE lining. Calculations in Appendix C show that the geotextile will resist clogging by the native sandy silt soils expected for use as the cover soil layer.

Free drainage of the subgrade drain is confirmed in the HELP model calculations. The liquid head in the subgrade drain does not exceed 4.2 inches under peak daily conditions. The average annual head in the subgrade drain is 0.007 inches. The HELP model results are provided in Appendix C.

Free drainage of the cover surface is maintained by adequate drainage course slopes. The central cover area will have a minimum slope of 3 percent. A raised earthen berm around the entire central cover area will form a 1-ft deep swale to route the stormwater flow to the single stormwater drop structure. The swale slope will be 1 percent. A combination of precast concrete drop boxes and HDPE piping will carry the stormwater down the exterior slope of the cell. A grassed lined outlet channel will be constructed at the foot of the 4:1 (H:V) slope to dissipate the hydraulic energy and route the stormwater to Dead Creek. These appurtenant structures are designed to handle a 32 cfs peak flow. The stormwater calculations for the cover system are provided in Appendix D.

5.4.5 Settlement and Subsidence

The foundation soils beneath the proposed containment cell are primarily sandy soils with little potential for consolidation or creep settlement. Most settlement will be immediate. The settlement potential for the cell is described in a previous paragraph. Settlement potential for the soil lining is minimal due to the components receiving moderate compactive effort and the total overburden weight being minor.

The wastes placed in the cell are largely inorganic soils with limited digestible material. The wastes will be dried prior to placement in the cell and they will be compacted during placement. The degree of compaction will not be specified for waste placement. Consolidation of the waste mass is not likely to be significant. Consolidation testing on the proposed wastes has not been performed. Correlations for consolidation potential generally show that settlement potential decreases as the material's liquid limit and moisture content decrease. In addition, the mechanically compacted soil should behave as an over-consolidated soil that has significantly less settlement potential than a normally-consolidated soil. The 16-ft maximum waste thickness makes it unlikely that the overburden stress will approach the normally-consolidated range for the wastes, therefore the over-consolidated settlement behavior should be valid for this analysis. The duration of waste placement will allow some of the potential settlement to occur prior to cover placement, further limiting the cover settlement. The cover system settlement is estimated as about 1-inch at the center of the cover. That deflection produces no measurable reduction in the cover grade. The waste consolidation calculations are provided in Appendix D.

The potential settlement for the foundation and wastes will not measurably alter the surface grades of the cover system. The precipitation runoff should not be affected by any cover settlement and the infiltration predicted by the HELP modeling should be valid for the life of the cell.

5.4.6 Freeze/Thaw Effects

The frost penetration depth in this region is about 3 ft. The GCL in the cover system will be 2 ft below ground surface. The cover system GCL will be subject to freeze/thaw action.

Freeze/Thaw action can reduce the effectiveness of impermeable soil barriers. This cover system will use a GCL as the impermeable soil barrier. Testing performed by GeoServices Inc. for James Clem Corporation in 1988, showed that the GCL becomes about one-half order of magnitude more permeable when subjected to freeze/thaw cycling. The permeability of the GCL used in the HELP modeling does include this reduction for the freeze/thaw effects. The infiltration rate through the cover system should represent long-term performance.

5.4.7 Anchorage

The anchor trench around the perimeter of the landfill will be excavated and the liner segments placed such that the field welds will run up and down the side slopes of the berms. The liner will be placed into the anchor trench, the backfill soils will be placed and then compacted. A detail of the anchorage for the geosynthetic liner is shown on Figures 5-4 and 5-5.

5.5 RUN-OFF CONTROL SYSTEMS

Stormwater run-off control during containment cell construction and filling will be performed as follows.

5.5.1 Design and Performance

During construction, storm water in the cell will be pumped from the cell and discharged to Dead Creek. During sediment transfer, storm water in the cell will be treated, as required, and discharged. For most of the waste placement process, stormwater is completely contained within the lined cell. All stormwater contacting the placed sediments will be handled by pumping to the filter dam at the downstream end of Creek Segment B.

During waste placement, the waste fill will be graded to create a collection sump from which stormwater will be pumped. Since the waste placement period is relatively short (about 6 months), the design storm for the open cell is a 1-year, 24-hour event. The rainfall amount is 2.71 inches. The stormwater volume from that storm is about 222,000 gallons. Approximately ¼ of the cell area would need to be left with a 1-ft depth to accommodate that stormwater volume.

For a 25-year, 24-hour storm, the rainfall amount is 6.02 inches. The stormwater volume from that storm is about 495,000 gallons. Approximately ¼ of the cell area would need to be left with a 2-ft depth to accommodate that stormwater volume.

Figure 5-4 presents the detail for run-off control during placement within the landfill. To reduce the stormwater volume, impermeable covers may be placed over the wastes to prevent contact with the stormwater. Stormwater ponded on the impermeable covers will be discharged to Dead Creek. As the waste elevation approaches the perimeter berm elevations, impermeable covers will be required over the wastes to limit stormwater contact.

Once the cover is installed, sedimentation will be controlled using best management practices. After vegetation is established there is no need to control runoff from the cell. Storm water runoff will be routed to a grassed lined outlet channel north of the cell that discharges to Dead Creek. Drawings for this swale, which is designed to handle a 25 year, 24 hour storm, are included as Figures 5-1 and 5-6 in the Design Report.

Perimeter ditching and a controlled downlet structure for stormwater falling on the landfill are incorporated into the design. At the confluence of the two swales located at the northwest corner of the landfill (at the top of the berm) stormwater will flow into two interconnected drop inlets placed at different elevations. The first pre-cast inlet will be placed at the confluence of the two swales and the second inlet will be placed immediately to the north and set at a lower elevation. The stormwater will then flow out of the lower inlet into the grassed lined channel with an ultimate outfall to Dead Creek, located east of the landfill. In addition, rip-rap will be added to the grassed lined channel, as appropriate, to provide further erosion protection.

5.5.1.1 Calculation of Peak Flow

Two methods were used to estimate the peak flow from the cover system; the Rational Method and TR-55. The calculations and the design of the inlet drainage structures are based on a 25-year, 24-hour storm event. Rainfall frequency distributions were taken from *Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois*, by Huff and

Angel. The original calculations for the stormwater system were performed using the TR-55 model. To estimate the time of concentration for sheet flow using TR-55, the model uses the following Manning's kinematic equation to compute T_c,

$$T_c = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,S^{0.4}}$$

Where:

T_c = Travel time (hr)
n = Manning's roughness coefficient
L = Flow length (ft)
P_2 = 2-year, 24-hour rainfall (in),
S = Slope of hydraulic gradient line (land slope, ft/ft)

The 2-year, 24 hour storm event is recommended for sheet flow distances that are less than 300 feet by TR-55. The peak flow for the 25-year, 24-hour storm is 27 cfs. The rational method was also used to determine the total runoff from the cover system and to size the inlet system. Based on the Rational method, a peak flow from the cover system is calculated to be 32 cfs. The cover system appurtenant structures were designed to handle the 32 cfs peak flow. These calculations are included in Appendix D.

At the confluence of the two swales located at the northwest corner of the landfill (at the top of the berm) stormwater will flow into two interconnected drop inlets placed at different elevations. The first pre-cast inlet will be placed at the confluence of the two swales and the second inlet will be placed immediately to the north and set at a lower elevation. Collected stormwater will flow out of the lower inlet into the grassed lined drainage ditch with an ultimate outfall to Dead Creek, located east of the landfill. In addition, rip-rap will be added to the grassed lined channel, as appropriate, to provide further erosion protection.

5.5.1.2 Management of Collection and Holding Units

The waste cell will be actively managed by the construction contractor to minimize delays to the work progress. The cell will be pumped out as soon as possible to resume the waste placement. Tank trucks, mobile tanks, or lined pools may be used to store stormwater and leachate that has contacted the wastes. The liquids will be treated onsite and discharged or will be transported to a POTW for treatment and disposal.

5.5.1.3 Construction

The stormwater run-off control system will be constructed primarily of waste materials and will be contained within the lined containment cell. The run-off control system will incorporate requirements to maintain storage capacity in a portion of the waste fill area or provide impervious barriers to avoid waste contact. The requirements for run-off control are contained in Appendix D. A construction quality control program will only assure the retention volume is met since the configuration changes daily and the cell is lined. When impervious linings are used, the retention volume may be reduced in proportion to the area covered.

5.5.1.4 Maintenance

The run-off control system will require daily maintenance to accommodate the daily filling progress. Maintenance activities will be limited to providing the required retention volume within the waste area.

5.6 CONTROL OF WIND DISPERSAL

The waste materials will consist primarily of soil and organic materials. The materials may produce dust if allowed to become too dry. Dust will not be allowed from the operations and the waste fill will be sprinkled with water to reduce any dust generation.

5.7 POST-CLOSURE RUN-OFF

Surface water run-off will be controlled by landscaping and diversion structures to promote run off away from the landfill. Erosion control will be maintained by appropriate landfill contouring and establishment of grass vegetation to stabilize the soil cover.

Surface run-off occurring after closure will not contact the waste material and therefore will be considered non-contaminated. Following closure of the landfill, stormwater will be discharged directly off-site to Dead Creek.

5.8 DRAINAGE STRUCTURES

Drainage structures used in the engineering design for stormwater management may include half-round corrugated metal pipe (CMP) channels, earth berms and channels, and rip rap channels. Drainage structures will be specified that adequately manage the volume of stormwater. Figure 5-1 presents a plan view of the final cover and stormwater management system for the cell. Earth berms and channels may be used to control on-site surface waters. Figure 5-5 presents the final cover system runoff control berm and swale. A cross section of the grassed lined stormwater channel located north of the landfill is shown in Figure 5-6. Figure 5-8 presents a profile of the landfill drop structure which routes collected stormwater to the grassed lined channel. Figure 5-9 presents the outlet detail for the drop structure to the grassed lined channel (Figure 5-6). Figure 5-10 presents the profile of the outlet channel at Dead Creek.

APPENDIX D

COVER SYSTEM COMPONENT DESIGN

Waste Consolidation

Purpose: Estimate Cover settlement due to waste consolidation

Configuration: Max. Waste thickness = 16'
Cover Soil thickness = 2'

Assumptions: Waste material is a sandy silt soil
Liquid Limit is less than 40
Material will be dried to meet paint filter reqmts
Material will be compacted to some degree in place

Calculations: Since actual consolidation parameters for waste are unavailable, use correlations to estimate parameters

For remolded clays: $C_c = 0.007(LL-7)$
$= 0.007(40-7)$
$= \underline{0.23}$

Since wastes will be compacted, using the C_c for normally consolidated soil above is not appropriate. Use C_r.

C_r is reportedly about 5 to 10% of C_c, source: An Introduction to Geotechnical Engineering, Holtz & Kovacs, Prentiss Hall, 1981, pg 341.

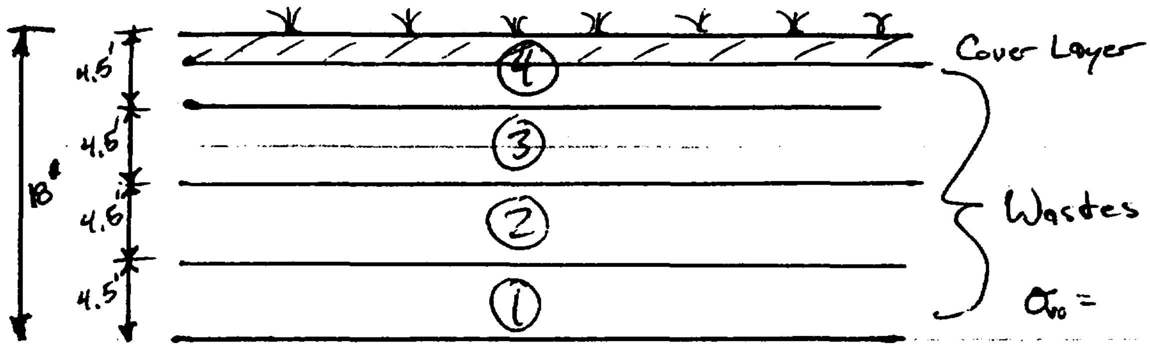
Use $C_r = 0.023$ in calculations

Void Ratio is unknown, but using 0.6 as the void ratio should produce conservative settlement results.

Use $e_o = 0.6$

URS Greiner Woodward Clyde

Job: Soluto Saxet	Project No. C10000399.00	Page ___ of ___	Sheet 2 of 2
Description: Waste Consolidation	Computed by: M. Brungard	Date: 5/12/00	
	Checked by: Bill Weber	Date: 5/25/2000	
		Reference	



Use $\gamma = 115$ pcf for wastes & cover

$$\text{settlement} = C_r \frac{H}{1+e_o} \log \frac{\sigma'_{vc} + \Delta\sigma_v}{\sigma'_{vc}} \quad ✓$$

use $\sigma'_{vo} = 2.25' \times 115\text{pcf} = 260\text{psf}$ at middle of each layer

Layer ① ; $\Delta\sigma_v = (3 \times 4.5') \times 115\text{pcf} = 1552$ psf

① settlement $= 0.023 \frac{4.5'}{1+0.6} \log \frac{260+1552}{260} = 0.05' = \underline{\underline{0.6''}}$ ✓

Layer ② ; $\Delta\sigma_v = (2 \times 4.5') \times 115\text{pcf} = 1035$ psf

② settlement $= 0.023 \frac{4.5}{1+0.6} \log \frac{260+1035}{260} = 0.045' = \underline{\underline{0.5''}}$ ✓

Layer ③ ; $\Delta\sigma_v' = 4.5' \times 115$ pcf $= 520$ psf

③ settlement $= 0.023 \frac{4.5'}{1+0.6} \log \frac{260+520}{260} = 0.03' = \underline{\underline{0.4''}}$

Layer ④ $\Delta\sigma_v = 2' \times 115$ pcf $= 230$ psf

④ settlement $= 0.023 \frac{2.5}{1+0.6} \log \frac{260+230}{260} = 0.01' = \underline{\underline{0.1''}}$

Total Settlement at Cover Surface $\approx \underline{\underline{1.6''}}$

Conclusion: The total settlement above is overstated since a portion of the settlement should occur during waste placement, reducing the actual settlement of the completed cover system.

The actual cover system settlement is estimated @ 1"

Run-off Velocity/Sheet Flow

URS Greiner Woodward Clyde

Job: Solutia Sauget	Project No. C10000 5899.00	Page ___ of ___	
Description: Runoff Velocity Sheet Flow	Computed by: M. Bruengard	Sheet 1 of 1	Date 5/10/00
	Checked by: Bill Weber	Date 5/25/2000	

Reference

Purpose: Estimate runoff velocity on cover system under sheet flow conditions.

Method: Use a Time of Travel (T_T) equation to estimate velocity.

Use Flow Length = 300' = (L)
slope = 3% to 12% = (S)
Manning Sheet Flow (n) = 0.15 – for short grass
2 yr - 24 hr Rain fall = 3.28 in from Huff & Angel, 1989 (P)

$$T_T = \frac{0.007 (nL)^{0.8}}{(P)^{0.5} S^{0.4}}$$

Solution:

(3%) $T_T = \frac{0.007(0.15(300'))^{0.8}}{\sqrt{3.28} \times 0.03^{0.4}} = .33 \text{ hr} = 1189 \text{ sec}$ ✓

(12%) $T_T = \frac{0.007(0.15(300'))^{0.8}}{\sqrt{3.28} \times 0.12^{0.4}} = .19 \text{ hr} = 683 \text{ sec}$ ✓

(3%) Velocity $= \frac{300'}{1189 \text{ sec}} = \underline{0.25 \text{ ft/sec}}$

(12%) Velocity $= \frac{300'}{683 \text{ sec}} = \underline{0.44 \text{ ft/sec}}$

Suitability of Grassed Surfaces for Erosion Control.

Based on the maximum allowable velocities for grassed channel linings on easily erodible soils, the max. velocity is about 3 ft/sec, from Table 10-5, Municipal Stormwater Management, Debo & Reese, Lewis Publishers, 1995.

* Therefore, grassed surfaces are permissible for the cover.
3 ft/sec >> 0.44 ft/sec

```
Quick TR-55 Ver.5.47    S/N:
Executed: 16:27:44    05-08-2000    s:\1999\00026\SAUGET1.TCT

                    Solutia Sauget Waste Area Peak Flow          MB


                         Tc COMPUTATIONS FOR: waste

 SHEET FLOW (Applicable to Tc only)
     Segment ID
     Surface description                         graded waste
     Manning's roughness coeff., n                      0.0110
     Flow length, L (total < or = 300)      ft          300.0
     Two-yr 24-hr rainfall, P2              in          3.280
     Land slope, s                          ft/ft       0.0200
                            0.8
          .007 * (n*L)
     T = --------------                     hrs          0.05          =   0.05
             0.5      0.4
          P2     *   s

 SHALLOW CONCENTRATED FLOW
     Segment ID
     Surface (paved or unpaved)?
     Flow length, L                         ft            0.0
     Watercourse slope, s                   ft/ft       0.0000

                              0.5
     Avg.V =   Csf *   (s)                  ft/s        0.0000
     where:    Unpaved Csf = 16.1345
               Paved   Csf = 20.3282

     T = L / (3600*V)                       hrs          0.00          =   0.00


 CHANNEL FLOW
     Segment ID
     Cross Sectional Flow Area, a           sq.ft        0.00
     Wetted perimeter, Pw                   ft           0.00
     Hydraulic radius, r = a/Pw             ft          0.000
     Channel slope, s                       ft/ft       0.0000
     Manning's roughness coeff., n                      0.0000

                         2/3      1/2
          1.49   *   r    *   s
     V = --------------------               ft/s        0.0000
                     n

     Flow length, L                         ft              0

     T = L / (3600*V)                       hrs          0.00          =   0.00

    ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                                  TOTAL TIME (hrs)      0.05
```

Quick TR-55 Version: 5.47 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

Solutia Sauget Waste Area Peak Flow

MB

CALCULATED
DISK FILE: s:\1999\00026\SAUGET1 .GPD

Drainage Area	(acres)	3	--->	0.0047 sq.mi.
Runoff Curve Number	(CN)	90		
Time of Concentration,Tc	(hrs)	.05		
Rainfall Distribution	(Type)	II		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	25		
Rainfall, P, 24-hr (in)	6.02		
Initial Abstraction, Ia (in)	0.222	0.222	0.222
Ia/p Ratio	0.037	0.000	0.000
Unit Discharge, * qu (csm/in)	1191	0	0
Runoff, Q (in)	4.87	0.00	0.00
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	27	0	0

Summary of Computations for qu

Ia/p	#1	0.100	0.000	0.000
C0	#1	2.553	0.000	0.000
C1	#1	-0.615	0.000	0.000
C2	#1	-0.164	0.000	0.000
qu (csm)	#1	1190.884	0.000	0.000
Ia/p	#2	0.100	0.000	0.000
C0	#2	2.553	0.000	0.000
C1	#2	-0.615	0.000	0.000
C2	#2	-0.164	0.000	0.000
qu (csm)	#2	1190.884	0.000	0.000
* qu (csm)		1191	0	0

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
  If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$

$$qp\ (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond\ \&\ Swamp\ Adj.)$$

Cover System Stormwater Control

URS

7650 West Courtney Campbell Causeway
Tampa, FL 33607-1462
Tel: 813.286.1711

JOB Sauget   SHEET 1 OF 3   PROJ. NO.
DESCRIPTION landfill cell Drainage   COMPUTED BY DOB   DATE 5/1/01
CHECKED BY [illegible]   DATE 5/1/01

Problem

1- Design a dropstructure to convey stormwater runoff from the top of the landfill to a perimeter ditch located at the North side of the landfill cell.

Given

Landfill drainage Area = 5 Ac.
Ditch lining : Grass
C = 0.8

Solution

- use Concrete structure w/Grate inlet fitted with 24" RCP
- Use Grassed ditch to Convey the flow with the following cross section:

Left side slope : 3:1
Right side slope = 4:1 (adjacent to landfill slope)
Bottom width = 2'
depth = 1.5

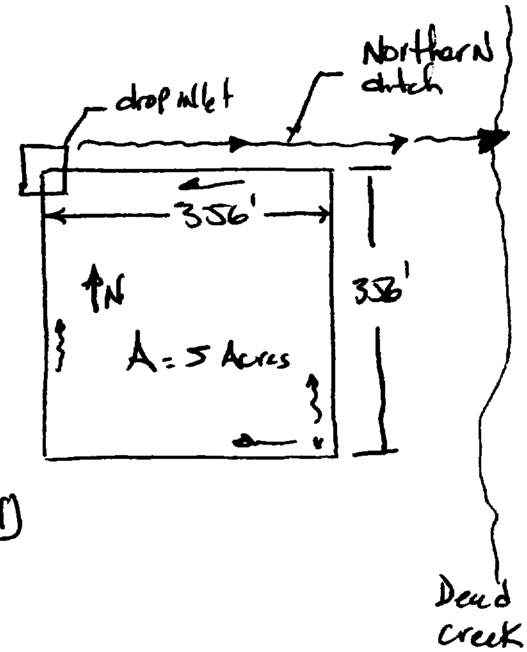
URS

7650 West Courtney Campbell Causeway
Tampa, FL 33607-1462
Tel: 813.286.1711

JOB Sauget . SHEET 2 OF 3 PROJ. NO.
DESCRIPTION Landfill Drainage system COMPUTED BY DCE DATE 5/1/01
CHECKED BY WJW DATE 5/1/01

Calculations

Use rational method to Calculate Q_{max}



$Q = CIA$

$C = 0.8$; $A = 5$ Ac

$T_c = \dfrac{356 \times 2}{60V}$

$V = 1.6$ ft/sec (from Fig 2-1 of TESS manual)

$\therefore T_c \simeq 12$ min.

$I_{25,24} = 7.96$ (Fig 4-202d)

$\therefore Q = 0.8 \times 7.96 \times 5 = 32$ ft^3/sec.

Size Drop inlet Pipe

$V^2 = 2gh$ (assuming Inlet Control)

$\dfrac{Q^2}{A^2} = 2gh$

$Q^2 = 2ghA^2$

Check head build up for 24-inch pipe

URS

7650 West Courtney Campbell Causeway
Tampa, FL 33607-1462
Tel: 813.286.1711

JOB Sauget SHEET 3 OF 3 PROJ. NO.
DESCRIPTION landfill Drainage system COMPUTED BY DATE 5/1/01
CHECKED BY WJW DATE 5/1/01

$(32)^2 = 2 \times 32.2 \times h \times (2.76)^2$

$\therefore h \approx 2.0$ ft

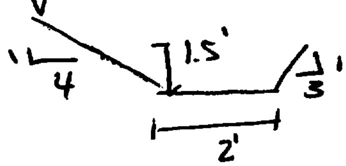
total inside inlet depth = 24" (pipe) + 2' (head) = 4 ft

Size ditch @ North end to carry $Q_{max} = 32$ ft^3/s.

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Assume ditch depth = 1.5 ft & bottom width = 2'

$A = (2 \times 1.5) + 3(1.5)^2 \times 0.5 + 4(1.5)^2 \times 0.5$
$= 10.83$ ft^2



$P = 12.93$

$R = \frac{10.83}{12.93} = 0.84$

$Q = \frac{1.486}{.02} \times 10.83 \times 0.84^{2/3} \times .005^{1/2} \approx 51$ ft^3/sec.

Since $Q_{calculated} > Q_{flow}$. ditch section ok.

Outlet Channel Design

PROBLEM: WILL DITCH HANDLE REQUIRED FLOW?

GIVEN: DITCH DIMENSIONS FROM DESIGN DRAWINGS

REQUIRED FLOW $Q = 51\ ft^3/s$ (FROM PREVIOUS CALCS)

REFERENCES: BEDIENT, PHILIP B., AND WAYNE C. HUBER, 1992, HYDROLOGY AND FLOODPLAIN ANALYSIS, 2nd ED, ADDISON-WESLEY PUBLISHING CO., NEW YORK.

CHOW, VEN TE, Ph.D., 1959, OPEN CHANNEL HYDRAULICS, McGRAW-HILL BOOK COMPANY, NEW YORK

"MANUAL FOR EROSION AND SEDIMENT CONTROL IN GEORGIA," 1990, GEORGIA SOIL AND WATER CONSERVATION COMMISSION.

ASSUMPTIONS: STATED IN CALCS

CONCLUSION: THE CALCULATIONS SHOW THE GIVEN CHANNEL FLOWING 20.7 in DEEP AT A VELOCITY OF 3.6 ft/s.

THE CHANNEL IS 24 in DEEP WHICH IS SUFFICIENT TO CONTAIN THE WATER

GIVEN A GRASS LINED CHANNEL WITH A BOTTOM SLOPE OF 0.4%, THE REFERENCES REQUIRE THE VELOCITY TO BE LESS THAN 5 ft/s. THE DESIGN VELOCITY IS 3.6 ft/s WHICH MEETS THIS CRITERIA.

∴ THE DITCH IS SUFFICIENT AS DESIGNED.

URS

Job: SOLUTIA SAUGET	Project No. C10000 4051.01	Page 2 of 6	Sheet ___ of ___
Description: CAPACITY CHECK FOR NORTH DITCH-DOWNCHUTE	Computed by WJW	Date 5/1/2001	
	Checked by DQE	Date 5/1/01	

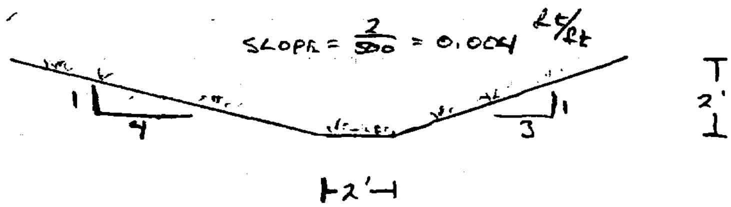
Reference

SOLUTION:

CALC. DEPTH

REQUIRED FLOW RATE $Q = 51\ ft^3/s$

CHANNEL DEMENSIONS



MANNING'S $n = 0.025$ (BEDIENT, 1992)

USING AUTOCAD TO SOLVE FOR MANNINGS EQUATION

$$V = \frac{1.49}{n} R^{2/3} \sqrt{S}$$

@ $Q = 51\ ft^3/s$ DEPTH = 20.8 in

∴ THE 24 in DEEP CHANNEL WILL CONTAIN THE FLOW

CONSIDER VELOCITY

AT $Q = 51\ ft^3/s$ THE FLOW VELOCITY IS $3.6\ ft/s$

FROM CHOW TABLE 7-6 AND THE GEORGIA DEVELOPMENT MANUAL TABLE 6-31, MOST GRASSES GROWN IN EASILY ERODED SOILS WITH A SLOPE LESS THAN 5% SHOULD HAVE A WATER VELOCITY LESS THAN $5\ ft/s$

∴ GIVEN THE BOTTOM SLOPE OF 0.4% AND THE WATER VELOCITY OF $3.6\ ft/s$ THE DESIGNED CHANNEL IS SUFFICIENT

TABLE 7.1

Values of Roughness Coefficient *n* in Manning's formula

NATURE OF SURFACE	*n* MIN	*n* MAX
Closed Conduits		
Neat cement surface	0.010	0.013
Wood-stave pipe	0.010	0.013
Plank flumes, planed	0.010	0.014
Vitrified sewer pipe	0.010	0.017
Metal flumes, smooth	0.011	0.015
Concrete, precast	0.011	0.013
Cement mortar surfaces	0.011	0.015
Plank flumes, unplaned	0.011	0.015
Common clay drainage tile	0.011	0.017
Concrete, monolithic	0.012	0.016
Brick with cement mortar	0.012	0.017
Cast iron	0.013	0.017
Cement rubble surfaces	0.017	0.030
Riveted steel	0.017	0.020
Canals and ditches, smooth earth	0.017	0.025
Metal flumes, corrugated	0.022	0.030
Canals		
Dredged in earth, smooth	0.025	0.033
In rock cuts, smooth	0.025	0.035
Rough beds and weeds on sides	0.025	0.040
Rock cuts, jagged and irregular	0.035	0.045
Natural Streams		
Smooth and straight	0.025	0.033
Rough weeds and stones	0.045	0.060
Very weedy, deep pools	0.075	0.150
Floodplains		
Pasture	0.025	0.05
Brush	0.035	0.16
Trees		
Dense willows	0.11	0.20
Cleared with stumps	0.03	0.05
Heavy timber	0.08	0.12

establishment, the grass will grow and the channel will be stabilized under a condition of low degree of retardance. The channel will not reach its maximum capacity until the grass cover is fully developed and well established. Therefore, it is suggested that the hydraulic design of a grassed channel consist of two stages. The first stage (A) is to design the channel for stability, that is, to determine the channel dimensions under the condition of a *lower* degree of retardance. The second stage

TABLE 7-6. PERMISSIBLE VELOCITIES FOR CHANNELS LINED WITH GRASS*

Cover	Slope range, %	Permissible velocity, fps	
		Erosion-resistant soils	Easily eroded soils
Bermuda grass	0–5	8	6
	5–10	7	5
	>10	6	4
Buffalo grass, Kentucky bluegrass, smooth brome, blue grama	0–5	7	5
	5–10	6	4
	>10	5	3
Grass mixture	0–5	5	4
	5–10	4	3
	Do not use on slopes steeper than 10%		
Lespedeza sericea, weeping love grass, ischaemum (yellow bluestem), kudzu, alfalfa, crabgrass	0–5	3.5	2.5
	Do not use on slopes steeper than 5%, except for side slopes in a combination channel		
Annuals—used on mild slopes or as temporary protection until permanent covers are established, common lespedeza, Sudan grass	0–5	3.5	2.5
	Use on slopes steeper than 5% is not recommended		

REMARKS. The values apply to average, uniform stands of each type of cover. Use velocities exceeding 5 fps only where good covers and proper maintenance can be obtained.

* U.S. Soil Conservation Service [41].

(B) is to review the design for maximum capacity, that is, to determine the increase in depth of flow necessary to maintain a maximum capacity under the condition of a *higher* degree of retardance. For instance, if common lespedeza is selected as the grass for lining, the common lespedeza of low vegetal retardance (green, average length 4.5 in.) is used for the first stage in design. Then, in the second stage, the common lespedeza of moderate vegetal retardance (green, uncut, average length 11 in.) should be used. Finally, a proper freeboard is added to the computed

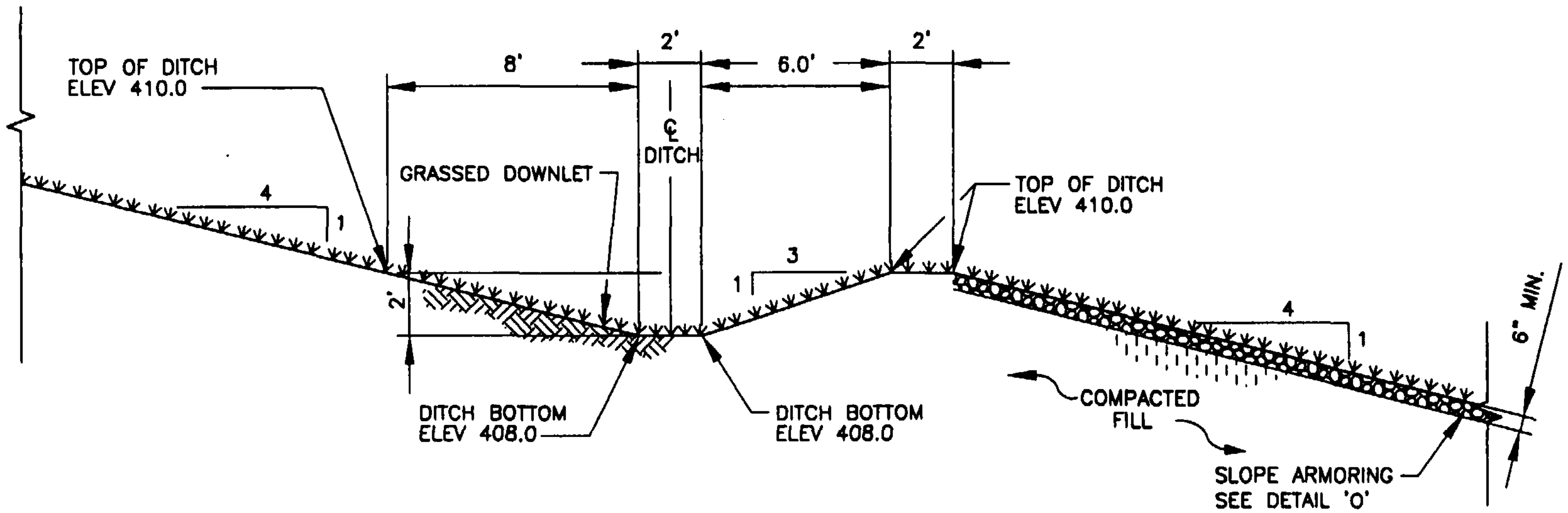
TABLE 6-31

PERMISSIBLE DESIGN VELOCITIES

Cover	PERMISSIBLE VELOCITY[1]		
	Slope range (percent)	Erosion Resistant Soils[5] (ft./sec.)	Easily Eroded Soils[6] (ft./sec.)
Bermuda	0-5 5-10 over 10	6 5 4	5 4 3
Tall Fescue Bahia	0-5 5-10 over 10	5 4 3	5 4 3
Grass-legume mixtures	0-5 5-10[2]	5 4	4 3
Sericea lespedeza Annuals[4] - Small grains (rye, millet) Rye grass	0-5[3]	3.5	2.5
Stone center	All	(as determined by stone size from Rp section)	

1 Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained.
2 Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
3 Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
4 Annuals - use on mild slopes or as temporary protection until permanent covers are established.
5 Erosion resistant soils include those with a higher clay content and high plasticity. Typical soil textures are silty clay, sandy clay, and clay.
6 Easily erodible soils include those with a high content of fine sand or lower plasticity. Typical soil textures are fine sand, silt, sandy loam, and silty loam.

S:\C10000\40\ .1.00\FINAL DESIGN REPORT\FIGURES\FIGURE 5-6.DWG 03/27/01 16:26



NOTE:

SLOPE ARMORING TO BEGIN AT ELEV 410.0 ALONG DOWNSHUTE.

SCALE = N.T.S.

PREPARED FOR: SOLUTIA

URS JOB NUMBER: C100004051.00

URS

URS Corporation Southern
7650 West Courtney
Campbell Causeway
Tampa, FL 33607-1462
No. 00000002

Drawn: W. WEBBER

Design: GARY WANTLAND

Checked: GARY WANTLAND

Date: APRIL 2, 2001

PROJECT NAME

SOLUTIA INC.
SAUGET AREA 1

DRAWING TITLE

DOWNCHUTE SECTION

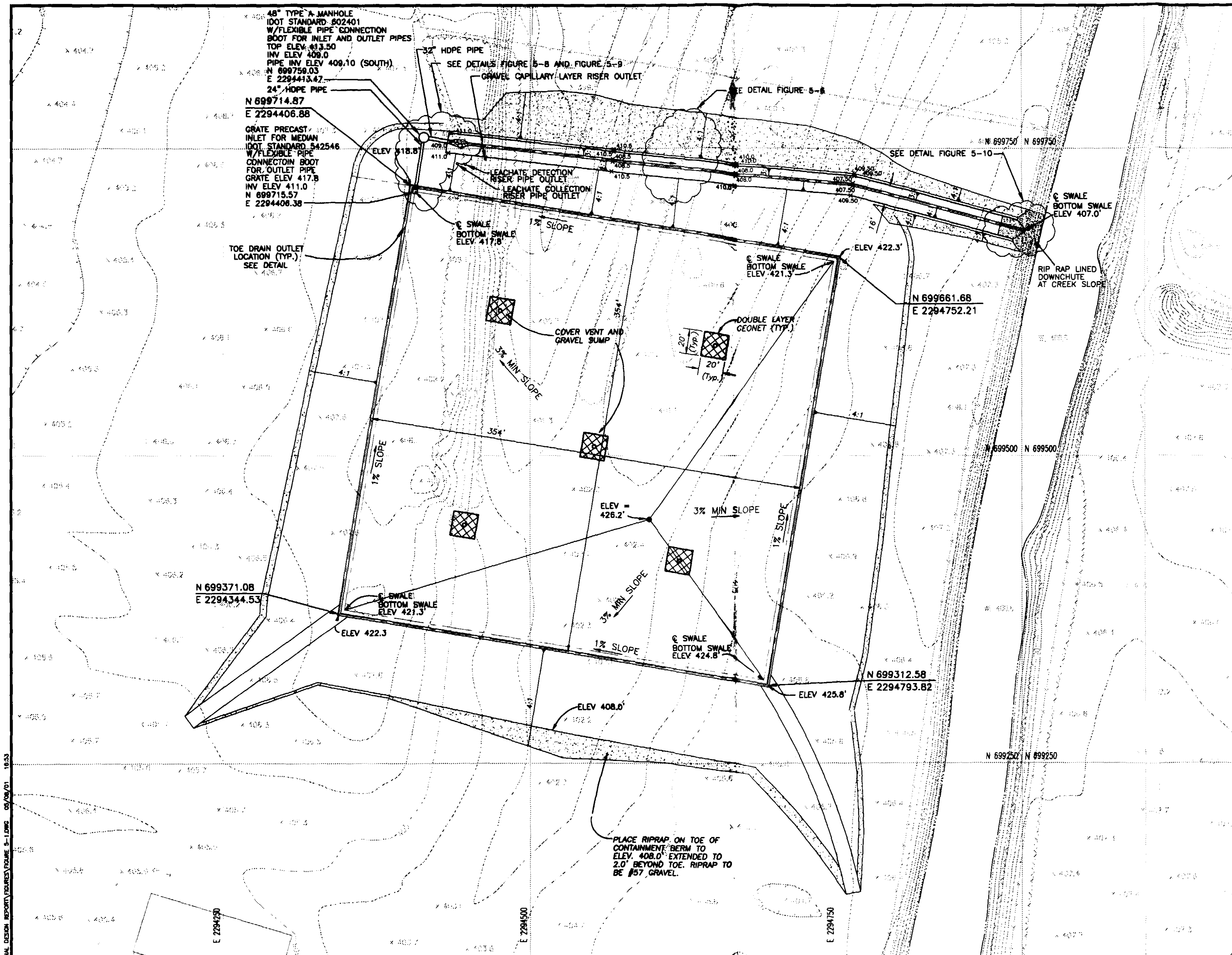
FIGURE
5-6

Page 6 of 6

Manning's Equation Output
From ACAD Land Development

Channel Calculator

	Given Input Data:	
Shape	Trapezoidal	
Solve for	Depth of Flow	
Flowrate	51.0000	cfs
Slope	0.0040	ft/ft
Manning's n	0.0250	
Height	24.0000	in
Bottom Width	24.0000	in
Left Slope	0.2500	ft/ft (V/H)
Right Slope	0.3333	ft/ft (V/H)
	Computed Results:	
Depth of Flow	20.7989	in
Velocity	3.6477	fps
Full Flowrate	71.5070	cfs
Area	18.0006	ft2
Perimeter	198.8560	in
Flow Area	13.9813	ft2
Flow Perimeter	175.5336	in
Hydraulic Radius	11.4697	in
Top Width	169.5982	in
Flow Condition	Subcritical	



REDUCED DRAWING – VERIFY SCALE

DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE:

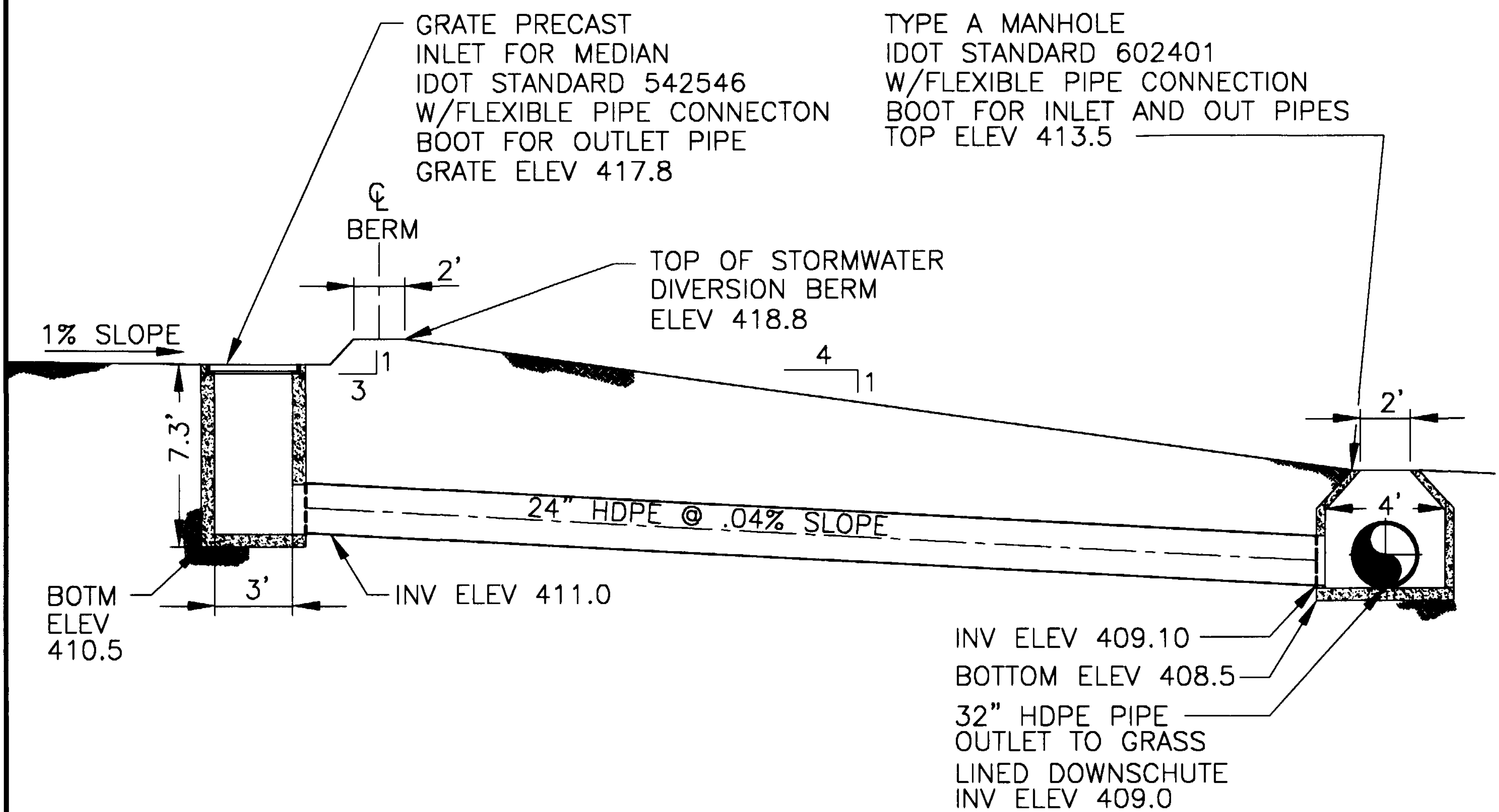
URS Corporation Southern
7650 West Courtney Campbell Causeway
Tampa, FL 33607-1462
No. 00000002

SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

COVER SYSTEM PLAN

PROJECT NUMBER C100004051.00

FIGURE 5-1

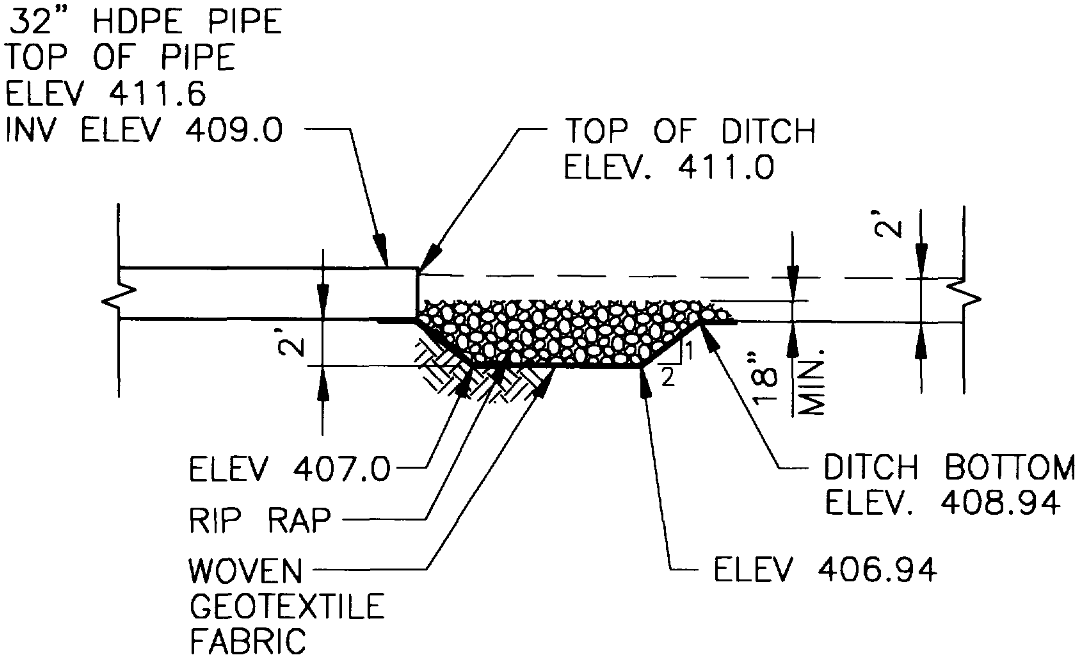


NOTE:

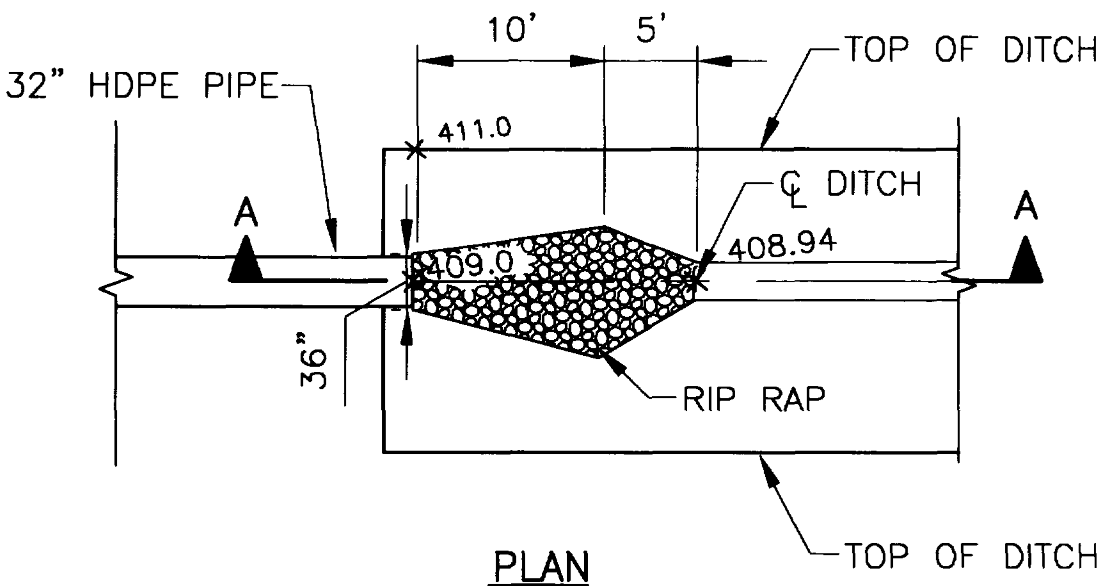
1. NOT FOR CONSTRUCTION.

SCALE = N.T.S.

PREPARED FOR: SOLUTIA URS JOB NUMBER: C100004051.00 URS Corporation Southern 7650 West Courtney Campbell Causeway Tampa, FL 33607-1462 No. 00000002	Drawn: BAD Design: GARY WANTLAND Checked: GARY WANTLAND Date: APRIL 2, 2001	PROJECT NAME **SOLUTIA INC.** **SAUGET AREA 1**	DRAWING TITLE **LANDFILL DROP STRUCTURE**	FIGURE 5-8



SECTION A–A

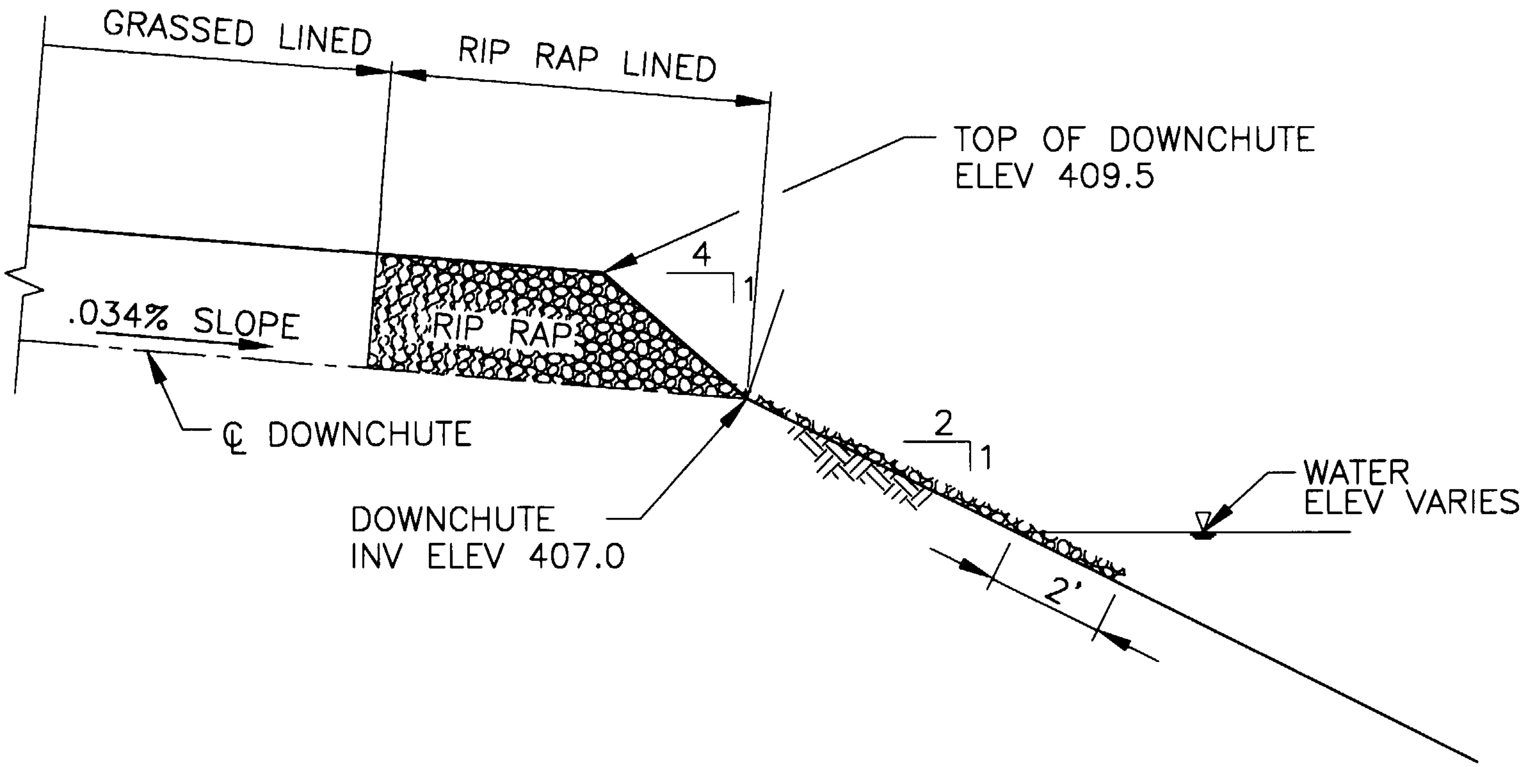


PLAN

NOTE:
1. NOT FOR CONSTRUCTION.

SCALE = N.T.S.

PREPARED FOR: SOLUTIA URS JOB NUMBER: C100004051.00 URS URS Corporation Southern 7650 West Courtney Campbell Causeway Tampa, FL 33607-1462 No. 00000002	Drawn: W. WEBER Design: GARY WANTLAND Checked: GARY WANTLAND Date: APRIL 2, 2001	PROJECT NAME SOLUTIA INC. SAUGET AREA 1 DRAWING TITLE **DOWNCHUTE OUTLET DETAIL**	FIGURE 5-9



NOTE:

1. NOT FOR CONSTRUCTION.

SCALE = N.T.S.

PREPARED FOR: SOLUTIA URS JOB NUMBER: C100004051.00 URS Corporation Southern 7650 West Courtney Campbell Causeway Tampa, FL 33607-1462 No. 00000002	Drawn: BAD Design: GARY WANTLAND Checked: GARY WANTLAND Date: APRIL 2, 2001	PROJECT NAME **SOLUTIA INC. SAUGET AREA 1**	DRAWING TITLE **RIPRAP LINED DOWNCHUTE AT DEAD CREEK OUTLET**	FIGURE 5-10